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Magnetic resonance imaging of the internal auditory meatus for vestibular schwannoma in ENT practice: a retrospective analysis with literature and guidelines review

M B Perera[1], N Janjua[1], R Swaminathan[1], C Apthorp[2] and H B Al-Deerawi[1]

[1]Department of ENT, Warwick Hospital, South Warwickshire NHS FoundationTrust, Warwick, UK and [2]Department of Surgery, North Manchester General Hospital, Manchester, UK

Review Article

Dr. M B Perera takes responsibility for the integrity of the content of the paper

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Author for correspondence:
Dr. M B Perera, Warwick Hospital, South Warwickshire NHS Foundation Trust, Lakin Road, Warwick CV34 5BW, UK
E-mail: mukun82@yahoo.co.uk

Abstract

Objectives. Magnetic resonance imaging scans of the internal acoustic meatus are commonly requested in the investigation of audio-vestibular symptoms for potential vestibular schwannoma. There have been multiple studies into protocols for requesting magnetic resonance imaging for vestibular schwannoma, but none have been reported based on UK National Institute for Health and Care Excellence guidelines for investigating audio-vestibular symptoms. This study intended to identify the local magnetic resonance imaging detection rates and patterns of vestibular schwannoma, and to audit the conformity of scan requests with the National Institute for Health and Care Excellence guidelines, with a review of relevant literature.

Method. A retrospective analysis of 1300 magnetic resonance imaging scans of the internal acoustic meatus, compared against National Institute for Health and Care Excellence guidelines, was conducted over two years.

Results and conclusion. Sixteen scans were positive for vestibular schwannoma, with a detection rate of 1.23 per cent. All positive cases fit the guidelines; three of these could have been missed using other criteria. A total of 281 requests did not meet the guideline criteria but revealed no positive results, supporting the use of National Institute for Health and Care Excellence guidelines in planning magnetic resonance imaging scans for audio-vestibular symptoms.

Introduction

Vestibular schwannomas, previously often referred to as acoustic neuromas, are rare benign tumours originating from the VIIIth cranial nerve, at the cerebellopontine angle. The presentation of vestibular schwannoma is varied; it often includes audio-vestibular symptoms of asymmetrical hearing loss (which can be of sudden onset), unilateral tinnitus or vertigo.[1] Neurological symptoms such as facial weakness or numbness can also be presenting features.[1] The incidence of vestibular schwannoma is variable across the literature, reported at rates of 1.04–1.4 per 100 000 population.[2–4] Vestibular schwannomas constitute about 85 per cent of cerebellopontine angle tumours.[1]

Magnetic resonance imaging (MRI) of the internal auditory meatus (IAM) is the most common imaging requested for patients with audio-vestibular symptoms, performed with the intention of ruling out a vestibular schwannoma. The indications include unilateral or asymmetrical hearing impairment, tinnitus, progressive hearing loss, vertigo, facial nerve palsy, and cholesteatoma. With regard to hearing loss and tinnitus, the UK's National Institute for Health and Care Excellence (NICE) has produced guidelines recommending criteria for requesting MRI of the IAM.[5,6] Audio-vestibular symptoms are relatively common, whereas vestibular schwannoma is relatively rare, even within the cohort of patients presenting with relevant symptoms. With MRI being one of the expensive imaging modalities, there is a significant financial burden associated with investigating common audio-vestibular symptoms in the hope of detecting a rare pathology. Hence, robust selection criteria for requesting an MRI of the IAM are important to streamline service and sustain cost-effectiveness, especially in the context of a stretched National Health Service.

The NICE guideline recommendations for investigation using MRI in adults with hearing loss are: (1) offer MRI of the IAM to adults with hearing loss, and localising symptoms or signs (such as facial nerve weakness) that might indicate a vestibular schwannoma or cerebellopontine angle lesion, irrespective of pure tone thresholds (NICE guideline (NG98) 1.3.1); and (2) consider MRI of the IAM for adults with sensorineural hearing loss and no localising signs if there is an asymmetry on pure tone audiometry of 15 dB or more at any two adjacent test frequencies, using test frequencies of 0.5, 1, 2, 4 and 8 kHz (NICE guideline (NG98) 1.3.2).[5] We used unilateral or asymmetrical hearing loss, unilateral tinnitus, facial nerve weakness, numbness or pain, and unilateral hyperacusis as localising symptoms and/or signs as per the guidelines.

This study aimed to compare the local hospital compliance with NICE guidelines and other guidance in terms of the detection rate of vestibular schwannoma.

Materials and methods

We carried out a retrospective study in our hospital: to establish whether we are following the NICE guideline NG98, entitled 'Hearing loss in adults: assessment and management',[5,6] published in 2018; and identify the rate of vestibular schwannoma detected from MRI of the IAM performed at the hospital.

Using data from the radiology department, MRI scans of the IAM requested between July 2017 and June 2019 were identified, and the clinical documentation leading to the request was reviewed. Ethical approval was not required because the study was performed as part of a service improvement project and signed off by the clinical governance, and patient-identifying information was not held. The total number of scans requested during this period was 1312. Included were all patients who underwent MRI of the IAM for audio-vestibular symptoms to exclude retro-cochlear pathology (n = 1300). Those patients who underwent MRI of the IAM for reasons other than audio-vestibular symptoms, such as stroke and cerebellar pathology, were excluded (n = 12).

The patients' demographic details were analysed for gender and age. All indications for MRI and the pure tone audiograms of patients included were assessed. Scans that fit NICE guidelines and those that did not were separately analysed, with corresponding patient records.

A literature review was performed, and the Oxford guidelines, Northern guidelines, Charing Cross protocol and Nashville Otology Group protocol were compared to evaluate their relative utility in identifying appropriate cases for investigation by MRI.[7–10]

Results

Of the 1300 patients whose scans were included in the study, the male to female ratio was 1.26:1. The age ranged between 11 and 90 years, with the mean age being 56.4 years.

The indication for the scan request was scrutinised: 494 patients (34 per cent) had a primary complaint of unilateral hearing loss, 423 (29 per cent) complained of unilateral tinnitus, whilst 105 (7 per cent) had both tinnitus and unilateral hearing loss. The other indications were: vertigo (n = 163, 11 per cent, with vertigo as the primary complaint); vertigo with hearing loss or tinnitus (n = 60, 4 per cent); sudden-onset sensorineural hearing loss (n = 68, 5 per cent); and 'other' indications, such as facial palsy or pain, or cholesteatoma (n = 152, 10 per cent) (Figure 1).

The scan results were normal in 95 per cent of the patients (n = 1235). Vestibular schwannoma was identified in 24 patients (1.8 per cent). Of these, 16 were newly diagnosed, whilst 8 had been diagnosed previously and the MRI requests had been performed for serial monitoring. Other pathologies were identified in 30 patients (2.3 per cent), including a vascular loop in 3 patients and ischaemia in 8 patients; it is unclear whether these findings explained the presenting symptoms.

The detection rate of new vestibular schwannoma was 1.23 per cent in our study. Scan requests for all 16 patients conformed to the NICE guidelines. We analysed the new positive scans and the indication for the MRI (Figure 2). Twelve patients with a scan positive for vestibular schwannoma had

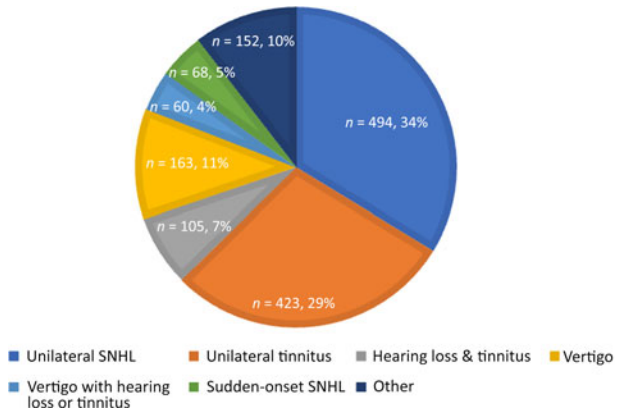

Fig. 1. Indications for requesting magnetic resonance imaging of the internal auditory meatus for audio-vestibular causes. SNHL = sensorineural hearing loss

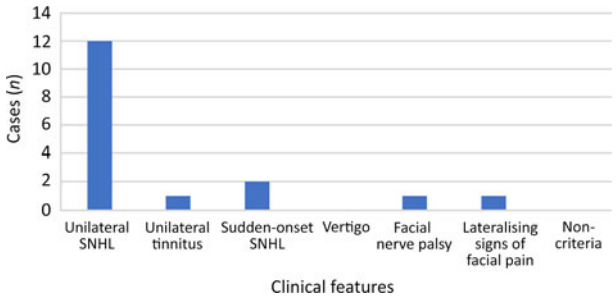

Fig. 2. Clinical features of 16 magnetic resonance imaging scans positive for vestibular schwannoma. SNHL = sensorineural hearing loss

unilateral sensorineural hearing loss, two had sudden-onset hearing loss, one had unilateral tinnitus, one had facial nerve palsy and one had lateralising signs of facial pain. It is noteworthy that one patient fulfilled the criteria for unilateral sensorineural hearing loss but was found to have vestibular schwannoma of the contralateral ear; however, this was not considered an incidental finding, as the patient met the NICE criteria for an MRI.

A total of 281 scan requests did not meet the NICE criteria, meaning that the compliance rate was 78.3 per cent. None of these scans showed any abnormal pathology. The main reason why the scan requests did not meet the criteria was mild sensorineural hearing loss that did not fit the specific hearing threshold levels stipulated by the NICE guidelines (n = 163, 58 per cent). Other conditions for which MRI of the IAM was inappropriately requested included: conductive hearing loss (n = 34, 12.1 per cent), Eustachian tube dysfunction (n = 12, 4.3 per cent), benign paroxysmal positional vertigo (n = 4, 1.4 per cent), bilateral tinnitus (n = 34, 12.1 per cent), and other conditions (n = 34, 12.1 per cent) such as mastoid and vascular pathologies (Table 1).

Whilst all patients with scans positive for vestibular schwannoma were picked up using NICE guidelines, up to three patients could have been missed using some of the alternative guidelines (which include the Oxford guidelines, Northern guidelines, Charing Cross protocol and Nashville Otology Group protocol). For instance, three cases might have been missed using the Oxford guidance, three cases by the Nashville Otology Group protocol, one by the Charing Cross protocol and two by the Northern guidelines. The criteria of these alternative guidelines are outlined in Table 2.

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Table 1. Analysis of MRI scans not adhering to NICE guidelines

Reasons for requesting imaging	Scans (*n* (%))
Not meeting SNHL criteria	163 (58)
Conductive hearing loss	34 (12.1)
Eustachian tube dysfunction	12 (4.3)
BPPV	4 (1.4)
Bilateral tinnitus	34 (12.1)
Other	34 (12.1)

MRI = magnetic resonance imaging; NICE = National Institute for Health and Care Excellence; SNHL = sensorineural hearing loss; BPPV = benign paroxysmal positional vertigo

Table 2. Different guidelines currently used as criteria for requesting MRI of IAM

Guidelines	Criteria for requesting MRI
NICE guidelines[6]	– Asymmetry on pure tone audiometry of 15 dB or more for any 2 adjacent test frequencies, using test frequencies of 0.5, 1, 2, 4 & 8 kHz – Localising signs irrespective of audiogram
Oxford guidelines[7]	– 15 dB asymmetry between mean thresholds of tested frequencies – Unilateral tinnitus with normal hearing
Northern guidelines[8]	– 20 dB asymmetry between 2 contiguous frequencies – Unilateral tinnitus
Charing Cross protocol[9]	– 20 dB asymmetry between 2 contiguous frequencies or 15 dB if normal hearing in 1 ear
Nashville Otology Group protocol[10]	– 15 dB asymmetry at 1 frequency (0.5–4 kHz) – Unilateral tinnitus

MRI = magnetic resonance imaging; IAM = internal auditory meatus; NICE = National Institute for Health and Care Excellence

Discussion

Vestibular schwannomas are diagnosed with different modalities of investigation; however, MRI of the IAM has become the primary modality of investigation, as it is non-invasive, with a sensitivity of 100 per cent and a specificity of 92 per cent.[11]

There are currently multiple locally produced guidelines for requesting MRI of the IAM to exclude retro-cochlear pathology, including the Oxford guidelines, Northern guidelines, Charing Cross protocol and the Nashville Otology Group protocol.[7–10] The NICE, as a national organisation, produced clear guidelines in 2018 for requesting MRI scans for audio-vestibular symptoms.[5,6]

To our knowledge, this is the first study to use the NICE guidance for MRI of the IAM selection criteria. In our work we have seen that within our population and practice, the NICE guidelines are suitable for detecting vestibular schwannoma. No underlying pathology was found in those patients who underwent MRI of the IAM without meeting the NICE criteria, further suggesting that the NICE guidelines are unlikely to miss a diagnosis of vestibular schwannoma.

The identification of incidental pathologies on MRI scans of IAM is well documented.[12] Our study found vascular loops, ischaemia and other incidental findings. One study reported a detection rate of 47.5 per cent for incidental pathologies,[13] of which a common finding was white matter lesions, which may be indicative of demyelinating disease. These incidental findings can result in patient anxiety and often require referral to other specialties, incurring further costs for the healthcare system. It is also often not clear whether these incidental findings have any relationship to the symptoms for which the MRI was requested.

Our oldest patient who underwent an MRI scan was 90 years old. The NICE guidelines do not state any age criteria for requesting MRI of the IAM in the investigation of audio-vestibular symptoms, but use of flexible terminology such as 'consider MRI'[5] in the guidelines allows clinicians some discretion. Previous studies have shown that elderly patients diagnosed with vestibular schwannoma have smaller tumours, which are now increasingly managed conservatively.[14] Some studies suggest that MRI of the IAM should not be recommended for this indication in those aged above 65–75 years, as initiation of interventional management is unlikely.[14,15] In our study, the mean age of patients with a scan positive for vestibular schwannoma was 52 years; the youngest patient was aged 26 years and the eldest was 71 years.

Other studies have examined the conformity of local centres with other criteria,[16] outlined in Table 2, but no comparison of data has been performed with the NICE guidelines. When we analysed our data against the other criteria (Table 3),[7–10] the negative likelihood ratio was 0.19 for the Oxford guidelines, 0.19 for the Northern guidelines, 0.06 for the Charing Cross protocol and 0.12 for the Nashville Otology Group protocol. It is noteworthy that a total of three patients would have been missed based on these alternative guidelines. One patient with a positive scan did not complain of hearing loss or tinnitus, but had facial pain and trigeminal neuralgia, with a mild sensorineural hearing impairment later revealed on audiogram. Therefore, this patient did fit the NICE criteria based on the unilateral localising symptoms. This might have been missed if the MRI request had been based purely on pure tone audiogram. Similarly, the other two patients would have had their diagnoses missed based on pure tone audiograms using the alternative guidelines.

Table 3. Comparison of data with other guidelines

Parameter	NICE guidelines[6]	Oxford guidelines[7]	Northern guidelines[8]	Charing Cross protocol[9]	Nashville Otology Group protocol[10]
Sensitivity (%)	100 (79.41–100)	81.25 (54.35–95.95)	81.25 (54.35–95.95)	87.50 (61.65–98.45)	93.75 (69.77–99.84)
Specificity (%)	100 (99.71–100)	100 (99.71–100)	100 (99.71–100)	100 (99.71–100)	100 (99.71–100)
Negative likelihood ratio		0.19 (0.07–0.52)	0.19 (0.07–0.52)	0.12 (0.03–0.46)	0.06 (0.01–0.42)
PPV (%)	100	100	100		100
NPV (%)	100	99.77 (99.36–99.92)	99.77 (99.36–99.92)	99.84 (99.43–99.96)	99.92 (99.48–99.99)
Accuracy (%)	100 (99.71–100)	99.77 (99.33–99.95)	99.77 (99.33–99.95)	99.85 (99.44–99.98)	99.92 (99.57–100)

Values in parentheses are 95 per cent confidence intervals. NICE = National Institute for Health and Care Excellence; PPV = positive predictive value; NPV = negative predictive value

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Although NICE guidelines are developed using the processes of systematic review and meta-analysis, they have not been compared within patient populations, as other guidelines have been, to assess reliability. Our study shows sensitivity and specificity rates that are similar to those of the above-mentioned alternative guidelines, which have comparable detection rates.[3] There is limited concordance between the various guidelines as to which criteria warrant referral for MRI of the IAM, so agreement on a single, suitable guideline would help clinicians and ensure a consistent standard of patient care.[16]

Conclusion

The NICE guidelines have raised awareness of limiting requests for MRI. Our study has identified that more than 200 patients locally had an MRI of the IAM requested without fulfilling the NICE criteria. This has resulted in unnecessary costs, potentially increased patient anxiety, and the identification of incidental findings with associated additional costs to the healthcare system. However, no case of vestibular schwannoma has been missed, and our results are comparable to the guidance.

Whilst NICE guidelines are effective in ensuring that those with vestibular schwannoma are investigated appropriately, following the criteria even more closely will enable the detection of vestibular schwannoma without risk of missing this pathology, and at the same time reduce investigation costs. The local detection rate of vestibular schwannoma is similar to other guidelines.

Lastly, questions have been raised over the utility of diagnosing and monitoring vestibular schwannoma in elderly patients; such patients tend to have smaller and slower-growing tumours, and often do not undergo intervention.[14,15] More advice from NICE regarding the suggestions around age criteria would further strengthen the indications for imaging.

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Competing interests. None declared

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